TITLE: The Sensitivity of the Global Water and Energy Cycles: An Integrated Assessment of Models and Observations

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1. Abstract

Understanding the processes which control the global water and energy budgets is essential for the successful modeling of the Earth's climate. The interactions between water vapor, clouds, and precipitation and their influence on the radiative and latent heating of the surface-atmosphere represent some of the most important and most controversial feedbacks within the climate system. Any strategy to improve the representation of these processes in models must include a way of testing the integrated global response of the models to an observable change in the water and energy cycles.

The NASA Earth System Enterprise (NASA ESE) has made significant investments to improve our understanding the water and energy cycles, both in terms of Earth observation resources and model analysis systems. Fully utilizing such investments requires an integrated comparison strategy which acknowledges the coupled nature of the hydrologic and energy budgets rather than considering either one in isolation.

This proposal seeks to exploit satellite-observed variability in the global energy and water cycles to: (1) better understand the mechanisms which govern changes in the intensity of the hydrological cycle, its coupling to the energy cycle, and their relation to precipitation extremes; and (2) to assess the ability of global climate models to simulate the observed variations and interactions.

The specific questions to be addressed under this proposal are:

- Are there observable manifestations of the relevant feedback processes which determine the sensitivity of the hydrological cycle?
- How are these changes linked to other components of the radiative energy budget? (i.e., do correlative data sets reveal physically-consistent behavior?)
- How are changes in the intensity of the hydrological cycle reflected in the modulation of precipitation extremes?
- What is the nature of the thermodynamic and dynamic environments which give rise to extreme precipitation events?
- How well can Global Climate Models (GCMs) simulate the observed linkages between the water and energy cycles and their relationship to precipitation extremes?

To address these questions, this research will exploit recent improvements in observational capabilities from NASA and the availability of long-term satellite records to test the integrated response of climate model against observable changes in the water and energy cycles, their feedback onto the climate system, and their association with extreme precipitation events. By adopting an integrated approach to the assessment of GCM simulations, this proposal seeks to enhance our understanding of the effects of hydrological processes on the Earth's climate and, in so doing, contribute to the NEWS program objective of "*documenting and enabling improved, observationally-based, predictions of water and energy cycle variability and change*".